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(54) **AUTONOMOUS MOBILE ROBOT AND CHARGING STATION SEEKING METHOD THEREFOR, CONTROL APPARATUS AND SMART CLEANING SYSTEM**

AUTONOMER MOBILER ROBOTER UND LADESTATIONSUCHVERFAHREN DAFÜR, STEUERUNGSVORRICHTUNG UND INTELLIGENTES REINIGUNGSSYSTEM

ROBOT MOBILE AUTONOME ET SON PROCÉDÉ DE RECHERCHE DE STATION DE RECHARGE, APPAREIL DE COMMANDE ET SYSTÈME DE NETTOYAGE INTELLIGENT

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(73) Proprietor: **Shenzhen Rock Times Technology Co., Ltd.**
Shenzhen, Guangdong 518000 (CN)

(72) Inventors:
- **WANG, Lei**
Shenzhen, Guangdong 518000 (CN)
- **XIE, Haojian**
Shenzhen
Guangdong 518000 (CN)

(74) Representative: **Laufhütte, Dieter**
Lorenz Seidler Gossel
Rechtsanwälte Patentanwälte
Partnerschaft mbB
Widenmayerstraße 23
80538 München (DE)

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Description

TECHNICAL FIELD

[0001] The present invention relates to the field of robot technologies, and more specifically, to an apparatus for controlling an autonomous mobile robot and a method for finding, by an autonomous mobile robot, a homing signal transmitted by a charging station.

BACKGROUND

[0002] Autonomous mobile robots are becoming more popular today. Autonomous mobile robots are usually equipped with charging stations. When an autonomous mobiel robot is in the low energy level, it can be charged at a charging station. In the convenntional docking method, the charging station transmits a signal and the autonomous mobile robot receives the signal; and when the autonomous mobile robot needs to be charged, a control system controls a driving system based on a homing signal sent by the charging station, so that the autonomous mobile robot moves towards the charging station for charging.

[0003] However, in practice, the following case may occur: A starting position of the autonomous mobile robot is far from the charging station, or there is an isolation zone between the starting position and the charging station. In this case, the autonomous mobile robot cannot detect the signal from the charging station. At this time, if the autonomous mobile robot needs to be recharged, there is a high probability that the charging station is not found, and an error is reported eventually. In this case, a user usually needs to place the autonomous mobile robot near or on the charging station before the robot can be recharged. Consequently, the poor operation lowers theuser experience.

[0004] Therefore, an autonomous mobile robot and a method for docking an autonomous mobile robot, a control device and a smart cleaning system are provided to resolve at least some of the above-mentioned issues.

SUMMARY

[0005] A series of simplified concepts are introduced in the SUMMARY section. These concepts are further described in detail in the DESCRIPTION OF EMBODIMENTS section. The SUMMARY section of the present invention does not imply an attempt to define the key features and essential technical features of the claimed technical solutions, nor does it imply an attempt to determine the protection scope of the claimed technical solutions.

[0006] To resolve at least some of the foregoing technical problems, an aspect of the present invention provides a method for finding, by an autonomous mobile robot, a homing signal transmitted by a charging station. The method includes:

S1: determining a first effective region based on the center of the autonomous mobile robot;

S2: determining an optimal point from a plurality of points on a boundary of the first effective region, wherein a remaining area corresponding to the optimal point is the largest, the remaining area being an area of a remaining region of a second effective region that does not overlap the first effective region, wherein the second effective region is determined by using each one of the plurality of points as the center point, and wherein neither the first effective region nor the second effective region comprises an obstacle;

S3: controlling the center of the autonomous mobile robot to move to the optimal point; and

S4: repeating steps S1-S3 until the autonomous mobile robot receives the homing signal from the charging station.

[0007] Optionally, the obstacle is a wall.

[0008] Optionally, the autonomous mobile robot includes a confied region detector.

[0009] Optionally, when the optimal point is located within a confined region detected by the autonomous mobile robot, the autonomous mobile robot is controlled to move along a boundary of the confined region until a location of the confined region is recorded.

[0010] Optionally, neither the first effective region nor the second effective region includes the confined region.

[0011] Optionally, the boundary of the confined region includes a virtual wall and/or a cliff edge.

[0012] Optionally, the confined region detector includes a virtual wall sensor and/or a cliff sensor.

[0013] Optionally, a radius of the first effective region is equal to a radius of the second effective region.

[0014] The present invention further provides an apparatus for controlling an autonomous mobile robot, wherein the autonomous mobile robot comprises a signal receiver, the apparatus comprising a memory, a processor, and a computer program that is stored in the memory and that runs on the processor, where the processor executes the program to perform the steps of the foregoing method.

[0015] The present invention further provides an autonomous mobile robot, where the autonomous mobile robot includes the foregoing apparatus.

[0016] Optionally, the autonomous mobile robot is a smart cleaning robot.

[0017] The present invention further provides a smart cleaning system, including a charging station and the foregoing autonomous mobile robot.

[0018] According to the method for finding, by an autonomous mobile robot, a homing signal transmitted by a charging station, the apparatus for controlling an autonomous mobile robot, the autonomous mobile robot, and the smart cleaning system in the present invention, the ability for seeking a charging station of the robot can be improved. To be specific, when the autonomous mobile robot cannot detect a signal from the charging station, the foregoing program in this application can be executed to enable the robot to automatically find the signal from the charging station through the inventive method. In this way, the robot does not need to be manually placed near or on the charging station, and manual intervention is reduced, thereby ensuring the intelligence and reliability of the robot, and improving user experience.

BRIEF DESCRIPTION OF DRAWINGS

[0019] The following describes embodiments of the present invention in detail with reference to accompanying drawings, so as to make the foregoing and other purposes, features, and advantages of the present invention clearer. The accompanying drawings are intended to provide a further explanation of the embodiments of the present invention and constitute a part of the present specification. Same reference numerals in the accompanying drawings usually represent same or similar parts or steps.

FIG. 1 is a schematic top view of an autonomous mobile robot according to a preferred embodiment of the present invention;
FIG. 2 is a schematic bottom view of an autonomous mobile robot according to a preferred embodiment of the present invention;
FIG. 3 is another schematic top view of an autonomous mobile robot according to a preferred embodiment of the present invention;
FIG. 4 is a schematic side view of an autonomous mobile robot according to a preferred embodiment of the present invention;
FIG. 5 is a schematic flowchart of a method for docking an autonomous mobile robot according to a preferred embodiment of the present invention;
FIG. 6 to FIG. 10 are schematic diagrams of a method for docking an autonomous mobile robot according to a preferred embodiment of the present invention;
FIG. 11 schematically shows a boundary of a confined region for an autonomous mobile robot according to a preferred embodiment of the present invention; and
FIG. 12 schematically shows a route of docking an autonomous mobile robot when encountering a confined region according to a preferred embodiment of the present invention.

DESCRIPTION OF EMBODIMENTS

[0020] FIG. 1 and FIG. 2 are schematic structural diagrams of an autonomous mobile robot according to an example embodiment. The structure of the autonomous mobile robot is described in detail below.

[0021] In the illustrated embodiment, the autonomous mobile robot is a cleaning robot 10. In addition to a machine body 1 and a cleaning system, the cleaning robot 10 includes a sensor system, a control system, a driving system, an power system, and a human-machine interaction system 9. The main parts of the cleaning robot are described in detail below.

[0022] The machine body 1 includes an upper cover, a front part 13, a rear part 14, a chassis 11, and the like. The machine body 1 be in an approximate circular shape (both the front and the rear are circular) or may be in other shapes, including but not limited to the approximate D-shape, that is, the front is straight and the rear is circular.

[0023] The sensor system includes sensing apparatuses such as a position determining apparatus disposed above the machine body 1, a bumper disposed on the front part 13 of the machine body 1, an ultrasonic sensor, an infrared sensor, a magnetometer, an accelerometer, a gyroscope, and an odometer. These sensing apparatuses provide various position information and motion state information of the machine for the control system. The position determining apparatus includes but is not limited to an infrared emitting and receiving apparatus, a camera, and a laser distance sensor (LDS).

[0024] The cleaning system includes a dry cleaning unit and a wet cleaning unit. The wet cleaning unit is a first cleaning unit 2, and its main function is to wipe a to-be-cleaned surface (such as a floor) by using a cleaning cloth 4 that contains cleaning liquid. The dry cleaning unit is a second cleaning unit, and its main function is to clean debris from the to-be-cleaned surface by using a structure such as a cleaning head.

[0025] The main cleaning function of the dry cleaning unit is derived from the second cleaning unit that includes a rolling brush 61, a dust container, a fan, an air outlet, and connecting parts among the four parts. The rolling brush 61 interfered with the surface sweeps debris on the surface and brings it to the front of a dust suction port between the rolling brush 61 and the dust container, and then the debris is conveyed into the dust container by an air suction stream generated by the fan and passing through the dust container. The dedusting capability of a cleaning machine can be represented by dust pick up efficiency (DPU). The DPU is affected by a structure and material of the rolling brush 61, wind power utilization of an air duct made up of the dust suction port, the dust container, the fan, the air outlet, and the connecting parts among the four parts, and by a type and power of the fan. A stronger dedusting capability is more significant for energy-limited cleaning robots than for conventional plug-in cleaners. A stronger dedusting capability directly and effectively reduces the energy requirement. For example a robot that can clean 80 square meters of the surface with a single charge can be improved to clean 100 or more square meters of the surface. In addition, as the number of charging times decreases, a service life of a battery increases greatly, so that frequency of replacing the battery by the user increased. More intuitively and importantly, a stronger dedusting capability is the most visible and important user experience, because it allows the user to directly determine whether the surface is clean after operation by the cleaning robot. The dry cleaning system may further include a side brush 62 having a rotation shaft. The rotation shaft is disposed at an angle relative to the floor, so as to move debris into a cleaning region of the rolling brush 61 of the second cleaning unit.

[0026] As the wet cleaning unit, the first cleaning unit 2 mainly includes a liquid tank 3, a cleaning cloth 4, and the like. The liquid tank 3 serves as a base for carrying other parts of the first cleaning unit 2. The cleaning cloth 4 is detachably disposed on the liquid tank 3. The liquid inside the liquid tank 3 flows to the cleaning cloth 4, and the cleaning cloth 4 wipes the surface cleaned by the rolling brush and the like.

[0027] The driving system is configured to drive the machine body 1 and the parts thereon to implement automatic walking and cleaning. The driving system includes a driving wheel module. The driving system can send a driving command to control the robot to move across the surface, based on distance and angle information such as components x, y, and θ. The driving wheel module can control a left wheel and a right wheel simultaneously. To control the movement of the machine more accurately, the driving wheel module preferably includes a left driving wheel module and a right driving wheel module. The left and right driving wheel modules are symmetrically disposed along a lateral axis that is defined by the machine body 1. To enable the robot to move more stably on the floor or to have a stronger motion ability, the robot may include one or more driven wheels, and the driven wheels include but are not limited to universal wheels.

[0028] The driving wheel module includes a traveling wheel, a driving motor, and a control circuit for controlling the driving motor. The driving wheel module can also be connected to a circuit for measuring a drive current, and to an odometer. The driving wheel module can be detachably connected to the machine body 1 for easy assembly, disassembly, and maintenance. The driving wheel may have a biased-to-drop suspension system that is secured in a movable manner. For example, the suspension system is attached to the machine body 1 in a rotatable manner, and receives a spring bias that is offset downward and away from the machine body 1. The spring bias allows the driving wheel to maintain contact and traction with the floor by using a specific touchdown force, and the cleaning element (such as the rolling brush) of the robot also contacts the floor with a specific pressure.

[0029] The front part 13 of the machine body 1 may carry a bumper. When the driving wheel module drives the robot to walk on the floor during cleaning, the bumper detects one or more events in the traveling route of the robot by using a sensor system, such as an infrared sensor. Based on the events detected by the bumper, such as obstacles and walls, the robot can control the driving wheel module to enable the robot to respond to the events, for example, keep away from the obstacles.

[0030] In general, when the robot is used, to prevent the robot from entering a confined region (for example, a region where fragile items are placed and a region having water on the floor, such as a bathroom) in the house, preferably, the cleaning robot further includes a confined region detector. The confined region detector includes a virtual wall sensor. The virtual wall sensor defines a confied region by setting a virtual wall based on the user's settings. As shown in FIG. 11, when detecting the virtual wall, the virtual wall sensor can control the driving wheel module to restrict the cleaning robot from entering the confined region by crossing a boundary 25 (i.e., the virtual wall) of the confined region.

[0031] In addition, when the robot is used, to prevent the robot from falling at, for example, an indoor staircase and a higher step, the confined region detector further includes a cliff sensor. The cliff sensor defines a confined region by setting a boundary based on the user's settings. As shown in FIG. 11, when detecting the boundary (i.e., a cliff edge) of the confined region, the cliff sensor can control the driving wheel module to restrict the cleaning robot from crossing the boundary 25 of the confied region, thereby preventing the robot from falling off the step.

[0032] The control system is provided on the main circuit board in the machine body 1. The control system includes a non-transitory memory, for example, a hard disk, a flash memory, or a random access memory, and includes computing processors used for communication, such as a central processing unit and an application processor. The application processor generates, based on obstacle information fed back by a laser distance sensor and by using a positioning algorithm such as SLAM, an instant map of an environment in which the robot is located. With reference to distance information and velocity information fed back by sensing apparatuses such as the bumper, the cliff sensor, the ultrasonic sensor, the infrared sensor, the magnetometer, the accelerometer, the gyroscope, and the odometer, the control system comprehensively determines a current working status of the cleaning machine, such as crossing a threshold, walking on a carpet, reaching a cliff, being stuck by the upper part or lower part, full dust container, or being picked up. In addition, the control system provides a specific next action strategy based on different situations, so that the robot better meets the user's requirements and delivers better user experience. Furthermore, the control system can plan a most efficient and reasonable sweeping route and sweeping manner based on information about the instant map that is drawn based on SLAM, thereby greatly improving the sweeping efficiency of the robot.

[0033] The power system includes a rechargeable battery, for example, a NiMH battery or a lithium battery. The rechargeable battery may be connected to a charging control circuit, a battery pack charging temperature detection circuit, and a battery undervoltage monitoring circuit. The charging control circuit, the battery pack charging temperature detection circuit, and the battery undervoltage monitoring circuit are connected to a single-chip microcomputer control circuit. The robot is charged by connecting a charging electrode disposed on a side or a lower part of the machine body to the charging station 21 (as shown in FIG. 6). If there is dust on the exposed charging electrode, the plastic part around the electrode may be melted and deformed due to a charge accumulation effect, or even the electrode may be deformed and cannot perform charging normally.

[0034] As shown in FIG. 3 and FIG. 4, the cleaning robot 10 is provided with a signal receiver 15 at the front and on the right side of the traveling direction for receiving signals from the charging station 21. Normally, when the robot leaves the charging station 21, the system records the position of the charging station 21. Therefore, when the robot finishes sweeping or the cleaning robot is in hte low energy level, the driving wheel system is controlled to drive the robot to move to the charging station 21 according to the position of the charging station 21 stored in the memory, and then is charged by the charging station.

[0035] The human-machine interaction system 9 includes buttons on a panel of the robot, which are used by the user to select functions. The human-machine interaction system 9 may further include a display screen, an indicator, and/or a speaker, which show the current status of the machine or function options for the user. The human-machine interaction system 9 may further include a mobile client application. For a route-navigated cleaning device, the mobile client application can show the user a map of the environment in which the robot is located, as well as the location of the robot, thereby providing the user with more abundant and user-friendly function options.

[0036] To describe behavior of the robot more clearly, the following describes definitions of directions. The robot can travel on the surface based on various combinations of movements relative to the following three mutually perpendicular axes defined by the machine body 1: the front-back axis X (that is, the axis along the direction of the front part 13 and the rear part 14 of the machine body 1), the lateral axis Y (that is, the axis perpendicular to the axis X and located on the same horizontal plane as the axis X), and the central vertical axis Z (the axis perpendicular to the plane formed by the axis X and the axis Y). The forward driving direction along the front-back axis X is marked as "forward", and the backward driving direction along the front-back axis X is marked as "backward". The lateral axis Y essentially extends between the right and left wheels of the robot along an axial center defined by the center point of the driving wheel module.

[0037] The robot can rotate around the axis Y. When the front part of the robot is tilted upward and the rear part is tilted downward, "pitchup" is defined. When the front part of the robot is tilted downward and the rear part is tilted upward, "pitchdown" is defined. In addition, the robot can rotate around the axis Z. In the forward direction of the robot, when the robot tilts to the right of the axis X, "right turn" is defined; and when the robot tilts to the left of the axis X, "left turn" is defined.

[0038] The dust container is mounted in a receptacle by means of buckle and handle. When the handle is clamped, a clamping part withdraws. When the handle is released, the clamping part protrudes out and is clamped in a recess for holding the clamping part in the receptacle.

[0039] With reference to FIG. 5 to FIG. 12, the following describes in detail a method according to the present invention.

[0040] A scenario suitable for the method according to the present invention is as follows: The cleaning robot does not start from the charging station 21, the memory of the robot does not store the position of the charging station 21, and there is a long distance (for example, greater than 5 m) between the cleaning robot and the charging station 21, or there is an isolation zone between the cleaning robot and the charging station 21, and the robot cannot detect the signal from the charging station 21. In this case, the robot needs to be charged and needs to detect the signal from the charging station 21.

[0041] The method according to the present invention is generally to use a scoring mechanism to control the robot to move as far as possible toward a position that is covered by the signal from the charging station 21. However, because the position of the charging station 21 cannot be determined, a mechanism is provided in the present invention to enable the robot to walk and seek the charging station in an optimized manner. Specifically, the robot is enabled to move toward an open region, because theoretically the signal from the charging station is received more easily in a more open region. Therefore, when the robot moves toward a more open region, the probability that the robot receives the signal from the charging station increases.

[0042] Specifically, as shown in FIG. 5 and FIG. 6, the processor of the robot first controls the execution of program S1: determining a first effective region based on the center of the autonomous mobile robot. Specifically, the robot determines a circular region by using the robot as the center at its starting position, and determines the first effective region 23 in the circular region. A radius of the circular region may be determined based on a model of the robot and an actual area of a house. In an embodiment, the radius of the circular region is set to 1.5 m. The effective region does not include obstacles such as walls, and does not include confined regions. For example, an example of the effectivve region is a shaded portion in the circular region in FIG. 6.

[0043] Then, the robot executes program S2: determining an optimal point on a boundary of the first effective region. The optimal point is a point around which there is a largest remaining area. The remaining area is defined as an area of a remaining region that belongs to a second effective region determined by using the optimal point as the center, and that does not overlap the first effective region. FIG. 7 and FIG. 8 are used as examples. In FIG. 7, assuming that A is the optimal point, the circular second effectice region 24 is determined by using A as the center, and the remaining region is the region of the second effective region 24 that does not overlap the first effectice region 23 (i.e., the shaded portion in the region 24). Similar to FIG. 7, the remaining region in FIG. 8 is a region that belongs to the second effective region 24 determined by using B as the center, and that does not overlap the first effective region 23 (i.e., the shaded portion in the region 24). Clearly, the remaining area in FIG. 8 is larger than the remaining area in FIG. 7. Therefore, the point B in FIG. 8 is determined as the optimal point. In practice, the robot can automatically determine the optimal point by using an operation program of its processor. Preferably, the radius detected by the robot when determining the second effective region 24 is equal to the radius detected by the robot when determining the first effective region 23.

[0044] Next, the robot performs step S3: controlling the center of the autonomous mobile robot to move to the optimal point; and step S4: repeating steps S1-S3 when the autonomous mobile robot moves to the optimal point, that is, continuing to determine a effective region based on the center of the autonomous mobile robot, and continuing to determine an optimal point on a boundary of the effective region. As shown in FIG. 9 and FIG. 10, according to the above-mentioned method for determining the optimal point, clearly, the traveling route of the robot in FIG. 10 is a preferred route. In this way, the robot can gradually move toward an open wide region until the robot detects a signal from the charging station for the first time. Then, the steps of the method for docking the robot ends, and the step of the conventional docking the robot is performed.

[0045] It should be noted that in each step the robot travels, there may be more than one determined optimal point, but the optimal points have the same weight. In practice, a traversal algorithm of the robot can determine a next point to travel toward. An overall trend is to enable the robot to move toward a wide region, so as to increase the probability of receiving a signal from the charging station.

[0046] As shown in FIG. 12, when a next optimal point determined by the robot is within a confined region detected by the robot, the robot is controlled to move along a boundary 25 of the confined region (i.e., a virtual wall or a cliff edge) until the robot records the location of the confined region. Specifically, the processor can mark the location of the confined region on the map constructed, and store the location in the memory, so that the robot can be controlled not to return to the confined region again.

[0047] The present invention further discloses an apparatus, including a memory, a processor, and a computer program that is stored in the memory and that runs on the processor, where the processor executes the program to perform the foregoing steps. The present invention further discloses an autonomous mobile robot that includes the apparatus, and a smart cleaning system. The smart cleaning system includes a charging station and the foregoing autonomous mobile robot.

[0048] According to the method, the apparatus for controlling an autonomous mobile robot, the autonomous mobile robot, and the smart cleaning system in the present invention, the a global docking an robot can be improved. To be specific, when the autonomous mobile robot cannot detect a signal from the charging station, the foregoing program in this application can be executed to enable the robot to automatically detect the signal from the charging station through the method. In this way, the robot does not need to be manually placed near or on the charging station, and manual intervention is further reduced, thereby ensuring the intelligence and reliability of the robot, and improving user experience.

Claims

1. A method for finding, by an autonomous mobile robot (10), a homing signal transmitted by a charging station (21), the method **characterized by**:

    S1: determining a first effective region (23) based on a center of the autonomous mobile robot (10);
    S2: determining an optimal point from a plurality of points on a boundary of the first effective region (23), wherein a remaining area corresponding to the optimal point is the largest, the remaining area being an area of a remaining region of a second effective region (24) that does not overlap the first effective region (23), wherein the second effective region (24) is determined by using each one of the plurality of points as a center point, and wherein neither the first effective region (23) nor the second effective region (24) comprises an obstacle;
    S3: controlling the center of the autonomous mobile robot (10) to move to the optimal point; and
    S4: repeating steps S1-S3 until the autonomous mobile robot receives the homing signal from the charging station (21).

2. The method of claim 1, wherein the obstacle is a wall.

3. The method of claim 1, wherein the autonomous mobile robot (10) comprises a confined region detector.

4. The method of claim 3, wherein when the optimal point is located within a confined region detected by the autonomous mobile robot (10), the autonomous mobile robot (10) is controlled to move along a boundary (25) of the confined region until a location of the confined region is recorded.

5. The method of claim 4, wherein neither the first effective region (23) nor the second effective region (24) comprises the confined region.

6. The method of claim 5, wherein the boundary (25) of the confined region comprises a virtual wall and/or a cliff edge.

7. The method of claim 6, wherein the confined region detector comprises a virtual wall sensor and/or a cliff sensor.

8. The method of claim 1, wherein a radius of the first effective region (23) is equal to a radius of the second effective region (24).

9. An apparatus for controlling an autonomous mobile robot (10), wherein the autonomous mobile robot comprises a signal receiver (15), the apparatus comprises a memory, a processor, and a computer program that is stored in the memory and that runs on the processor, and the processor is configured to execute the program to perform the steps of the method according to any one of claims 1 to 8.

10. An autonomous mobile robot (10), comprising the apparatus according to claim 9.

11. The autonomous mobile robot (10) of claim 11, wherein the autonomous mobile robot (10) is a smart cleaning robot.

12. A smart cleaning system, comprising:

a charging station (21); and
the autonomous mobile robot (10) according to claim 10 or 11.

Patentansprüche

1. Verfahren zum Auffinden eines von einer Ladestation (21) gesendeten durch einen autonomen mobilen Roboter (10), wobei das Verfahren **gekennzeichnet ist durch**:

S1: Bestimmen eines ersten effektiven Bereichs (23) auf der Grundlage eines Zentrums des autonomen mobilen Roboters (10);
S2: Bestimmen eines optimalen Punktes aus einer Vielzahl von Punkten auf einer Grenze des ersten effektiven Bereichs (23), wobei eine verbleibende Fläche, die dem optimalen Punkt entspricht, die größte ist, wobei die verbleibende Fläche eine Fläche eines verbleibenden Bereichs eines zweiten effektiven Bereichs (24) ist, der den ersten effektiven Bereich (23) nicht überlappt, wobei der zweite effektive Bereich (24) bestimmt wird, indem jeder der Vielzahl von Punkten als ein Mittelpunkt verwendet wird, und wobei weder der erste effektive Bereich (23) noch der zweite effektive Bereich (24) ein Hindernis umfasst;
S3: Steuern des Zentrums des autonomen mobilen Roboters (10), um den optimalen Punkt anzufahren; und
S4: Wiederholen der Schritte S1-S3, bis der autonome mobile Roboter das Zielführungssignal von der Ladestation (21) empfängt.

2. Verfahren nach Anspruch 1, wobei das Hindernis eine Wand ist.

3. Verfahren nach Anspruch 1, wobei der autonome mobile Roboter (10) einen Detektor für begrenzte Bereiche umfasst.

4. Verfahren nach Anspruch 3, wobei, wenn sich der optimale Punkt innerhalb eines begrenzten Bereichs befindet, der von dem autonomen mobilen Roboter (10) erfasst wird, der autonome mobile Roboter (10) so gesteuert wird, dass er sich entlang einer Grenze (25) des begrenzten Bereichs bewegt, bis eine Position des begrenzten Bereichs aufgezeichnet wird.

5. Verfahren nach Anspruch 4, wobei weder der erste effektive Bereich (23) noch der zweite effektive Bereich (24) den begrenzten Bereich umfasst.

6. Verfahren nach Anspruch 5, wobei die Grenze (25) des begrenzten Bereichs eine virtuelle Wand und/oder eine Felskante umfasst.

7. Verfahren nach Anspruch 6, wobei der Detektor für einen begrenzten Bereich einen virtuellen Wandsensor und/oder einen Felssensor umfasst.

8. Verfahren nach Anspruch 1, wobei der Radius des ersten effektiven Bereichs (23) gleich dem Radius des zweiten effektiven Bereichs (24) ist.

9. Vorrichtung zum Steuern eines autonomen mobilen Roboters (10), wobei der autonome mobile Roboter einen Signalempfänger (15) umfasst, wobei die Vorrichtung einen Speicher, einen Prozessor und ein Computerprogramm umfasst, das in dem Speicher gespeichert ist und auf dem Prozessor abläuft, und wobei der Prozessor so konfiguriert ist, dass er das Programm ausführt, um die Schritte des Verfahrens nach einem der Ansprüche 1 bis 8 durchzuführen.

10. Autonomer mobiler Roboter (10), umfassend die Vorrichtung nach Anspruch 9.

11. Autonomer mobiler Roboter (10) nach Anspruch 11, wobei der autonome mobile Roboter (10) ein intelli-

genter Reinigungsroboter ist.

12. Intelligentes Reinigungssystem, das Folgendes umfasst:

eine Ladestation (21); und
der autonome mobile Roboter (10) nach Anspruch 10 oder 11.

Revendications

1. Un procédé pour trouver, par un robot mobile autonome (10), un signal de retour émis par une station de charge (21), le procédé étant **caractérisé par** les étapes suivantes :

S1 : déterminer une première région effective (23) basée sur un centre du robot mobile autonome (10) ;
S2 : déterminer un point optimal à partir d'une pluralité de points sur une limite de la première région effective (23), dans laquelle une zone restante correspondant au point optimal est la plus grande, la zone restante étant une zone d'une région restante d'une seconde région effective (24) qui ne se chevauche pas avec la première région effective (23), dans laquelle, la seconde région effective (24) est déterminée par l'utilisation de chacun de la pluralité de points comme un point central, et dans lequel ni la première région effective (23) ni la seconde région effective (24) ne comprend d'obstacle ;
S3 : commander le centre du robot mobile autonome (10) pour le déplacer vers le point optimal ; et
S4 : répéter les étapes S1-S3 jusqu'à ce que le robot mobile autonome reçoive le signal de retour de la station de charge (21).

2. Procédé selon la revendication 1, **caractérisée en ce que** l'obstacle est un mur.

3. Procédé selon la revendication 1, **caractérisée en ce que** le robot mobile autonome (10) comprend un détecteur de région confinée.

4. Procédé selon la revendication 3, dans lequel lorsque le point optimal est situé à l'intérieur d'une région confinée détectée par le robot mobile autonome (10), le robot mobile autonome (10) est commandé pour se déplacer le long d'une limite (25) de la région confinée jusqu'à ce qu'un emplacement de la région confinée soit enregistré.

5. Procédé selon la revendication 4, **caractérisée en ce que** ni la première région effective (23) ni la seconde région effective (24) ne comprennent la région confinée.

6. Procédé selon la revendication 5, **caractérisée en ce que** la limite (25) de la région confinée comprend un mur virtuel et/ou un bord de falaise.

7. Le procédé selon la revendication 6, **caractérisée en ce que** le détecteur de région confinée comprend un capteur de mur virtuel et/ou un capteur de falaise.

8. Procédé selon la revendication 1, **caractérisée en ce que** un rayon de la première région effective (23) est égal à un rayon de la seconde région effective (24).

9. Un appareil pour commander un robot mobile autonome (10), **caractérisée en ce que** le robot mobile autonome comprend un récepteur de signaux (15), l'appareil comprend une mémoire, un processeur, et un programme informatique qui est enregistré dans la mémoire et qui s'exécute sur le processeur, et le processeur est configuré pour exécuter le programme afin d'exécuter les étapes du procédé selon l'une quelconque des revendications 1 à 8.

10. Un robot mobile autonome (10), comprenant l'appareil selon la revendication 9.

11. Robot mobile autonome (10) selon la revendication 11, **caractérisée en ce que** le robot mobile autonome (10) est un robot de nettoyage intelligent.

12. Un système de nettoyage intelligent, comprenant :

une station de charge (21) ; et
le robot mobile autonome (10) selon la revendication 10 ou 11.

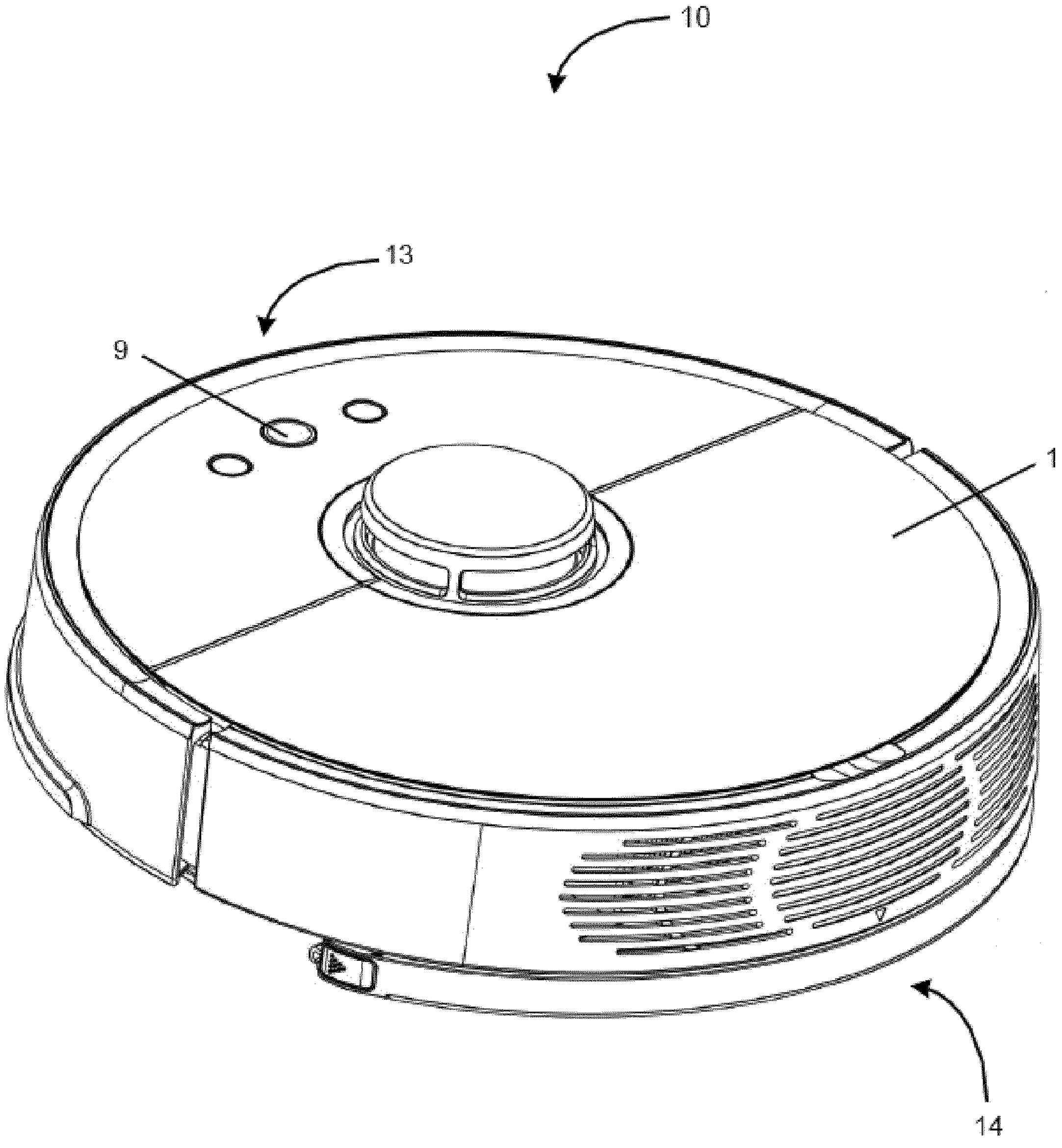

FIG. 1

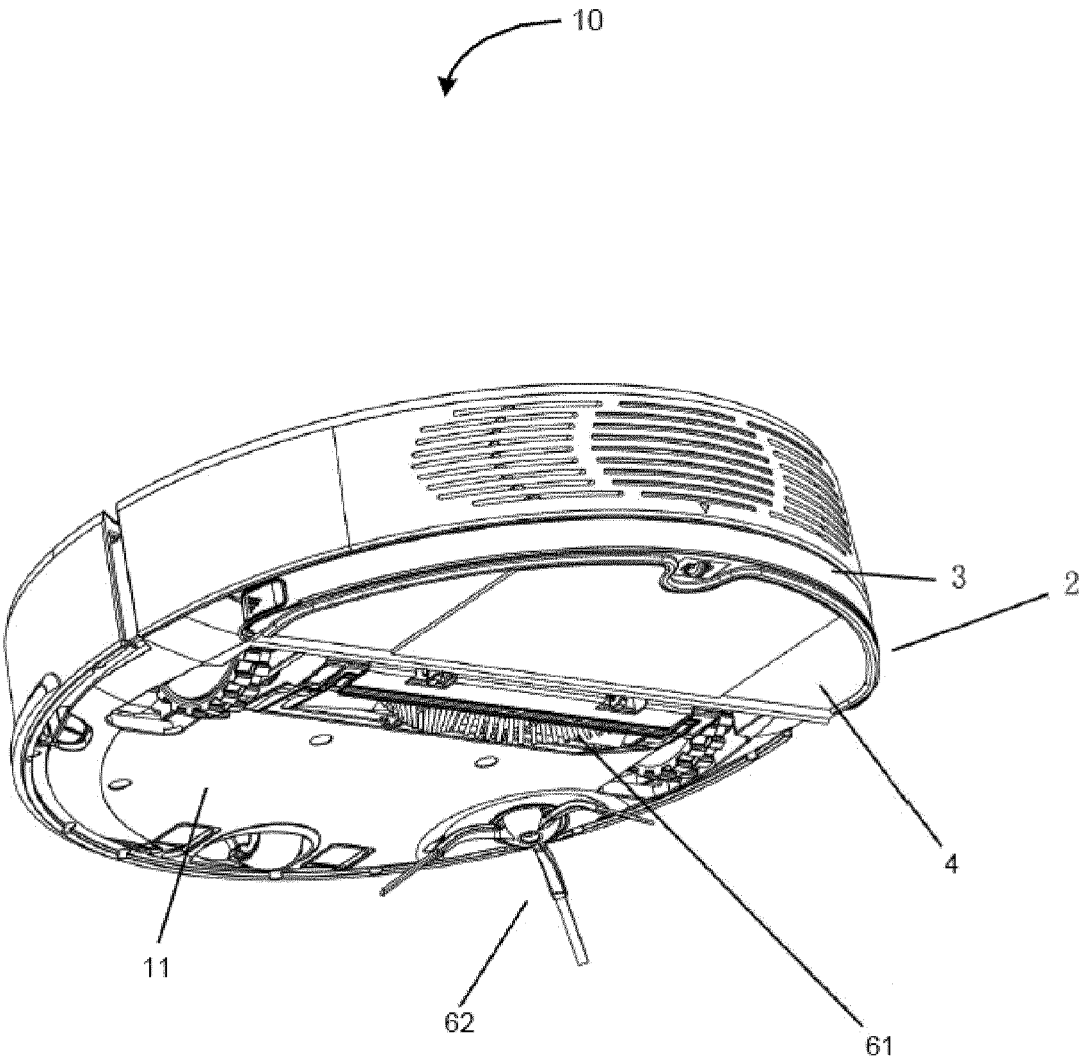

FIG. 2

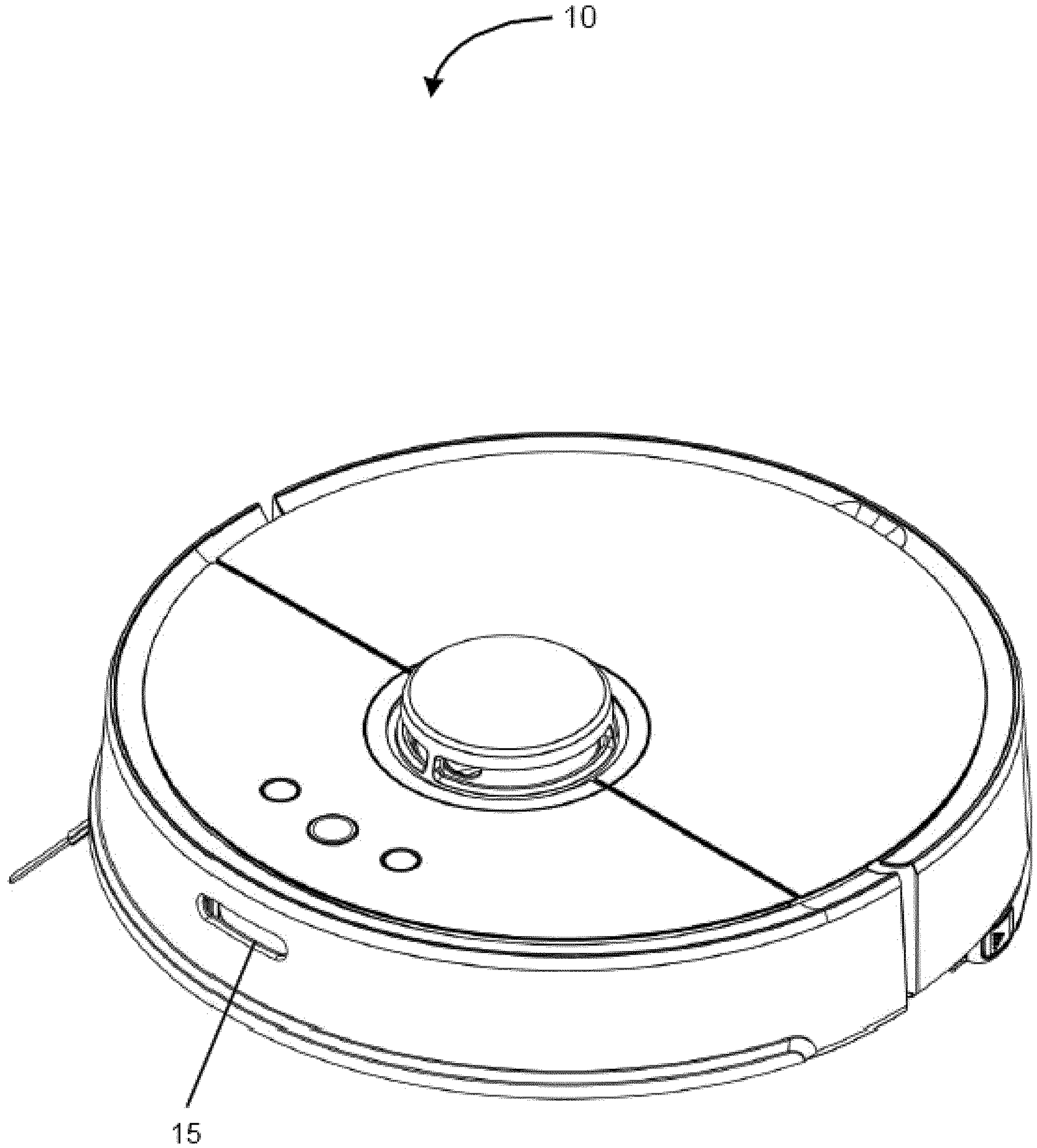

FIG. 3

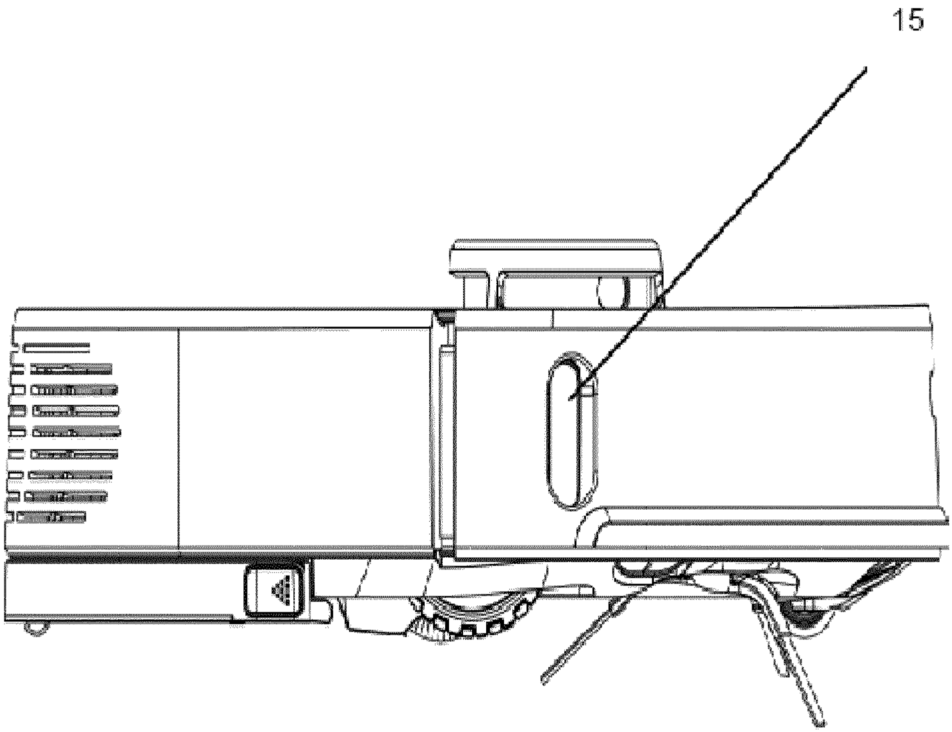

FIG. 4

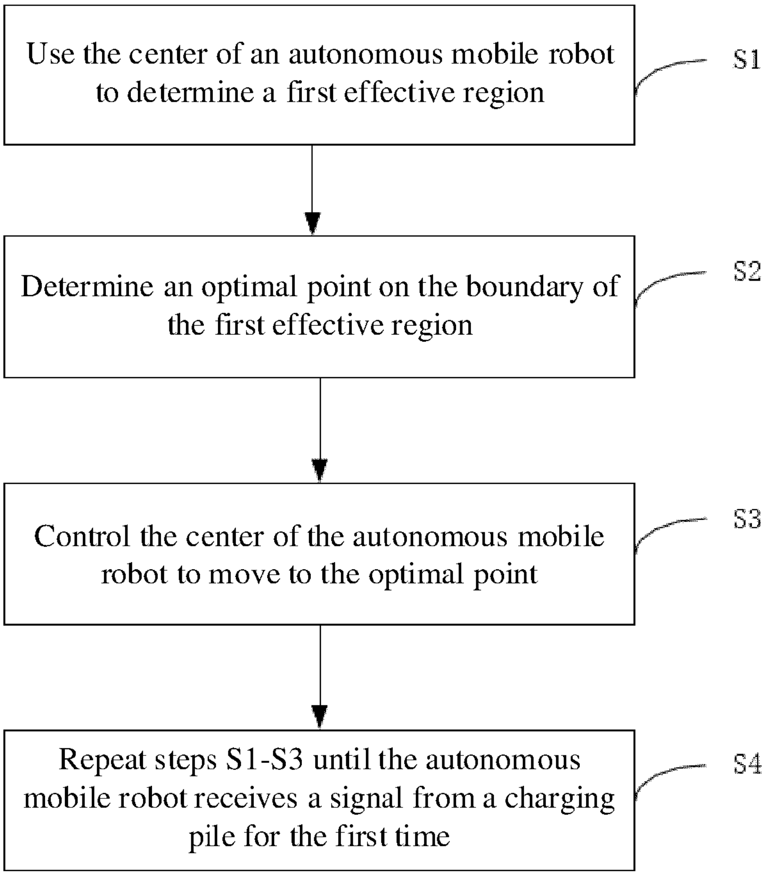
Use the center of an autonomous mobile robot to determine a first effective region
S1
Determine an optimal point on the boundary of the first effective region
S2
Control the center of the autonomous mobile robot to move to the optimal point
S3
Repeat steps S1-S3 until the autonomous mobile robot receives a signal from a charging pile for the first time
S4

FIG. 5

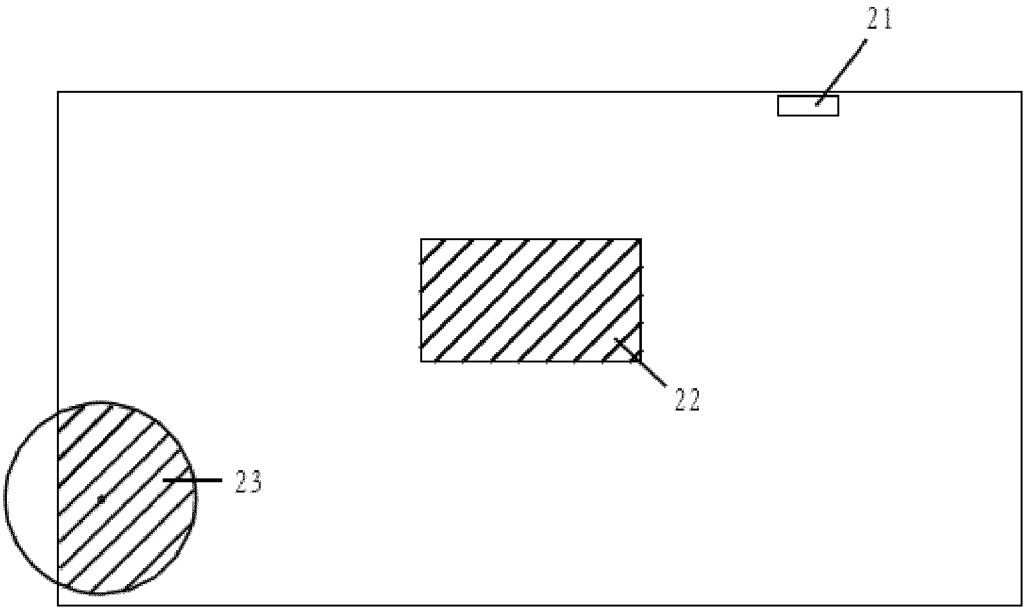
21
22
23

FIG. 6

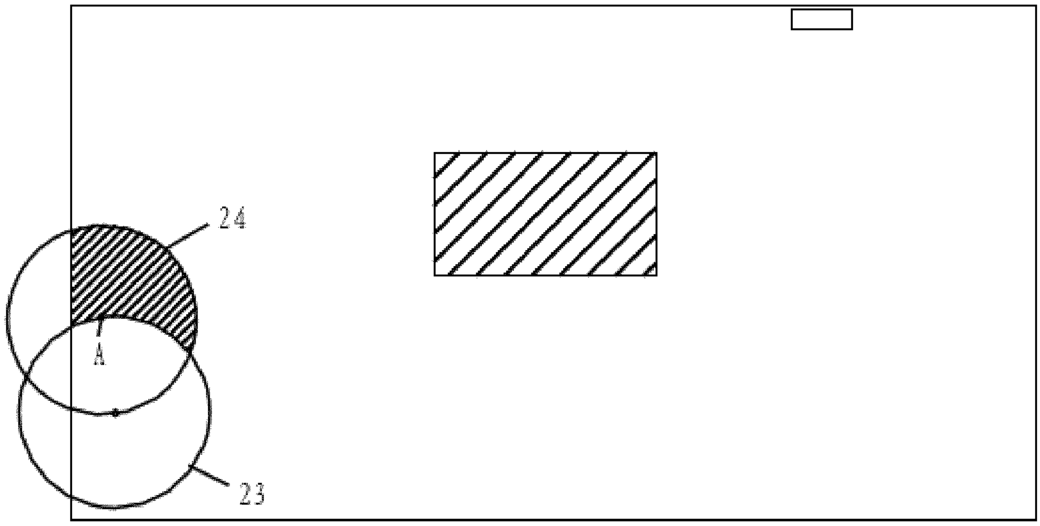

FIG. 7

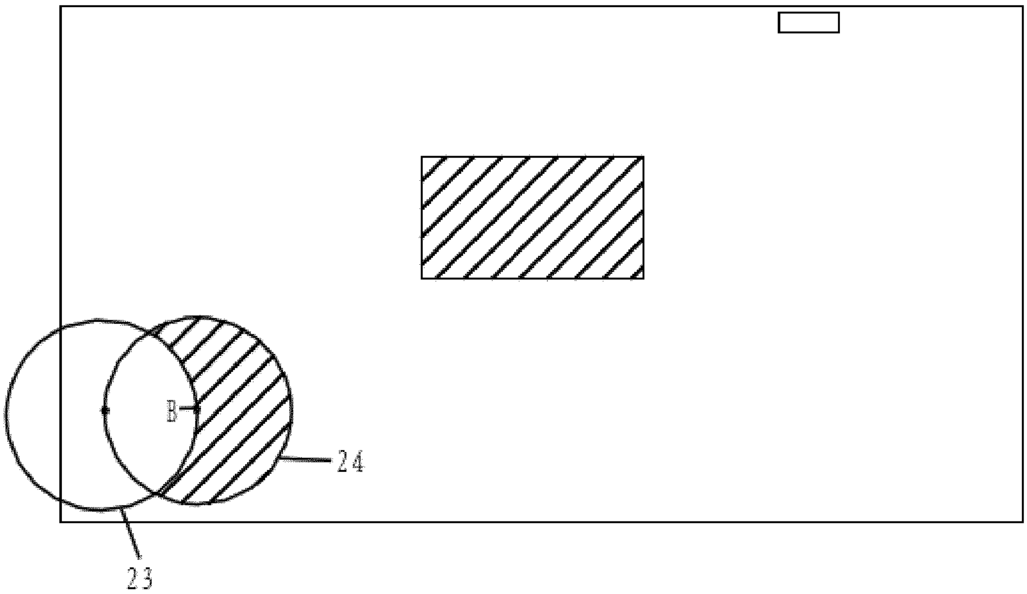

FIG. 8

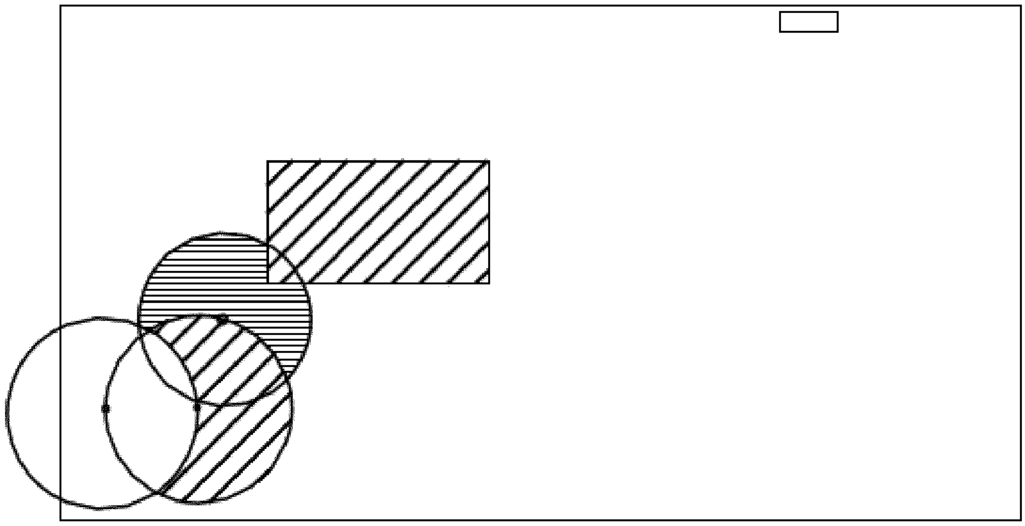

FIG. 9

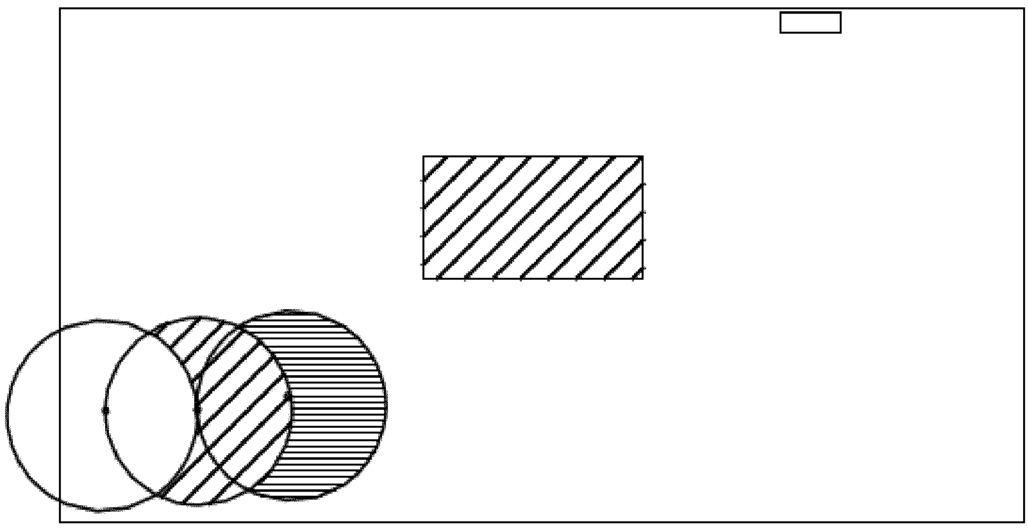

FIG. 10

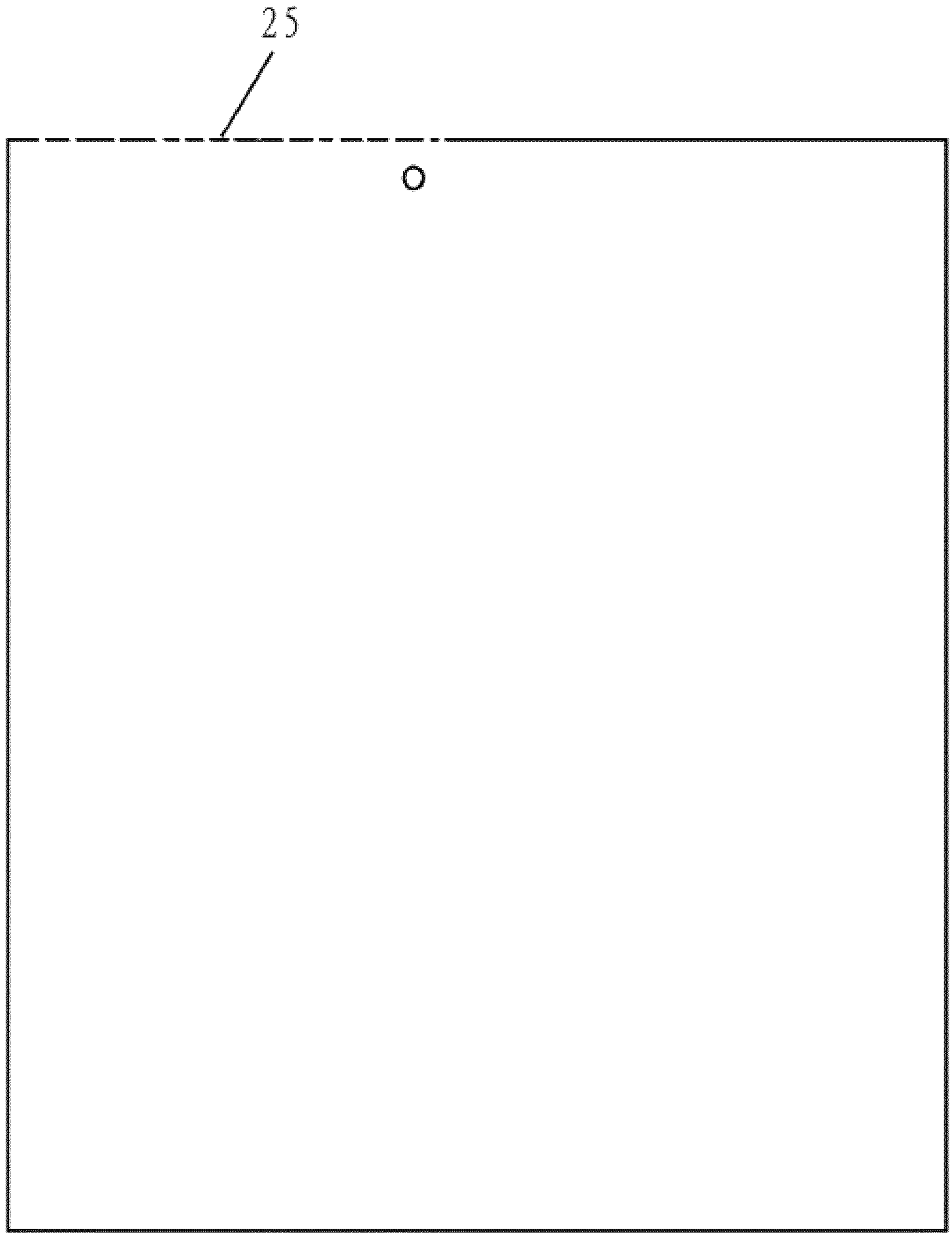

FIG. 11

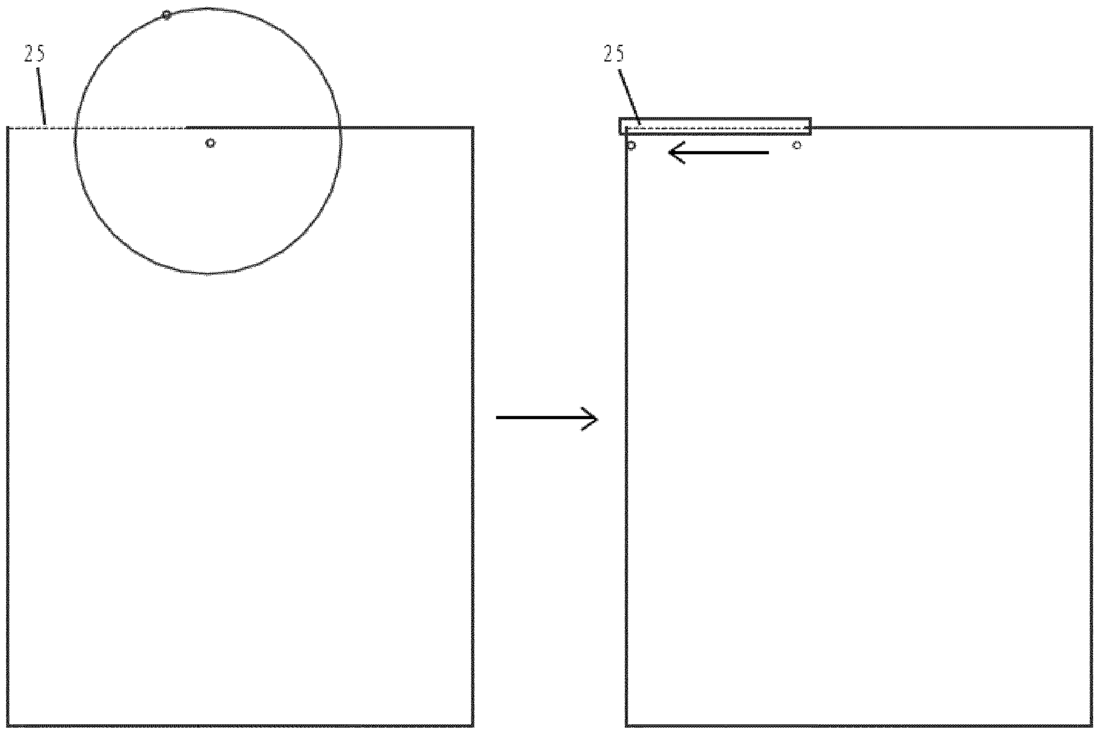

FIG. 12